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During the period June 6, 1994 - March 15, 1997, the Joint Services Electronics Program (JSEP) has supported research at UC Berkeley by 10 faculty, and 14 graduate students. Our work has resulted in 107 publications in journals or conference proceedings, 8 Ph.D. degrees and 7 M.S. degrees. The Berkeley JSEP effort has been organized into two main thrusts: (1) Semiconductor Physics and Devices and (2) Artificial Neural Networks.

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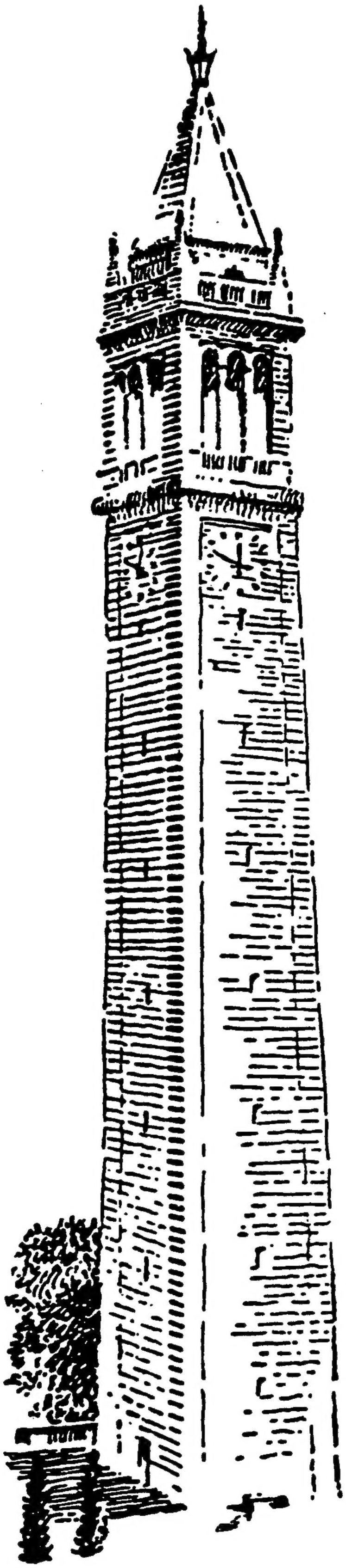

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JOINT SERVICES ELECTRONICS PROGRAM

FINAL REPORT
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Jeffrey Bokor

15 May 1997

Prepared for:

Air Force Office of Scientific Research/NE
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A. DIRECTOR'S OVERVIEW

During the period June 6, 1994 - March 15, 1997, the Joint Services Electronics Program (JSEP) has supported research at UC Berkeley by 10 faculty, and 14 graduate students. Our work has resulted in 107 publications in journals or conference proceedings, 8 Ph.D. degrees and 7 M.S. degrees.

The Berkeley JSEP effort has been organized into two main thrusts: (1) Semiconductor Physics and Devices and (2) Artificial Neural Networks.

In the area of Semiconductor Physics and Devices, we have maintained a balanced program of research in both electronics and optoelectronics, with efforts in basic physics, materials, and devices.

In basic physics, one of the frontiers we have concentrated on is the area of ultrafast carrier dynamics in semiconductors, which is so important in determining the ultimate limits of high speed electronic and optoelectronic devices. We have developed new instrumentation for studying these problems, including methods suitable for the study of carrier dynamics in silicon, which is difficult to characterize using conventional femtosecond laser techniques. A new method for directly measuring carrier dynamics in quantum-well semiconductor diode lasers was also developed. In a classic example of scientific serendipity leading to a practical application that was totally unanticipated, it was found that hot carriers created in silicon by femtosecond laser pulses can release surface micromachined structures which had failed due to stiction. This offers a potential solution to an important problem in micro-electromechanical systems (MEMS) technology.

In the materials area, a unique hollow anode nitrogen source was developed for ion-assisted MBE growth of GaN. This source provides high fluxes of low kinetic energy ions, which minimizes damage, leading to excellent structural and luminescent properties. It also has the additional advantage of very low contamination. A breakthrough was also made in the synthesis of silicon-on-insulator material using the separation by plasma implantation of oxygen (SPIMOX) technique. The process involves the use of plasma immersion implantation (PII) a technique pioneered at Berkeley. A combination of careful study of the plasma physics, the implantation physics, and the annealing process using a full suite of materials analysis techniques was crucial to this success.

In the electronic devices area, research in nanoscale silicon devices has continued to produce numerous outstanding accomplishments. MOSFETs with gate oxide thickness of only 1.5 nm were fabricated and shown to be promising for future VLSI. MOSFETs with channel lengths down to 800 nm were also successfully fabricated and studied. Saturation velocity and overshoot velocity in inversion layers was quantitatively measured using special test structures invented at Berkeley. Most notably, a highly promising new device structure called dynamic-threshold MOSFET (DT-MOS) was invented and demonstrated to provide high speed and low leakage at power supply voltage as low as 0.5 V. This device will have a major impact in the low-power mobile electronics area. Work on optoelectronic devices has let to the invention of several novel vertical cavity surface emitting laser (VCSEL) structures, including the use of oxide current confinement while maintaining single transverse mode operation, as well as incorporation of an intracavity quantum-well structure for a feedback detector or intracavity modulator.

In our companion theme of Artificial Neural Networks, dramatic advances were made in the cellular neural network (CNN) area. The first fully functional CNN Universial chip was produced and tested. On the theoretical side, the minimum level of complexity of implementation of the CNN that is required in order to achieve a Turing equivalent computing machine was established. Prac-

B. PRINCIPAL INVESTIGATORS

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C. ADVANCED DEGREES AWARDED

R. Rosenholtz	Ph.D.	October 1994	Local Shape From Texture
T. Fu	M.S.	Aug. 1994	Growth and Characterization of GaN Using a Substrate BiasingMethod
P. Tsai	M.S.	July 1994	Neural-Net Based, In-Line Focus/Exposure Monitor
A. Oliveira	Ph.D.	Dec. 1994	Inference of State Machines from Examples of Behavior
F. Assaderaghi	Ph.D.	Dec. 1994	Deep Sub-Micrometer Silicon-On-Insulator (SOI) MOSFETs
J. Liu	Ph.D.	May 1995	Formation of SOI Structure Using Separation by Plasma Implantation of Oxygen (SPIMOX)
S. Wu	M.S.	June 1995	Properties of Stochastic Auditory-Event-Based Models for Automatic Speech Recognition
J. Chan	Ph.D.	Dec. 1995	GaN Semiconductor Device Issues
C. Wu	Ph.D.	Dec. 1995	Some Aspects of Order in Circuits and Systems
M. Chan	Ph.D.	Oct. 1995	Nanometer Silicon Device Design, Fabrication and Characterization
D. Sinitsky	M.S.	May 1995	Velocity Overshoot in MOSFET's
C. Wann	Ph.D.	Feb. 1996	Advanced MOSFET Devices for VLSI Memory and Logic
B. Yu	M.S.	May 1996	Lateral Channel Engineering in Deep-Submicron MOSFET's
J. Margolies	M.S.	May 1996	Generation and Propagation of High Field Terahertz Electromagnetic Pulses
L. Schloss	M.S.	Dec. 1996	GaN Semiconductor Device Issues

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